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Technology Demonstration Mission Program

The Bridge

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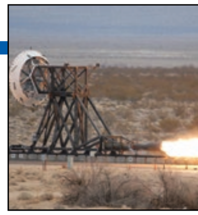
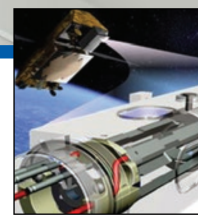




Engineers at Deployable Space Systems Inc. pose with their Mega-ROSA solar array, designed to roll out like a carpet. (Image: DSS Inc.)

TDM Family Welcomes Solar Electric Propulsion Project

By Rick Smith

In November, NASA announced a new addition to the Technology Demonstration Mission Program: the Solar Electric Propulsion (SEP) project.

Led by NASA's Glenn Research Center in Cleveland, the project will deliver a highly efficient, solar-powered alternative to conventional chemical-propelled spacecraft. Technologies matured and delivered by the project potentially could support commercial, near-Earth applications and revolutionize solar system exploration missions — including cost-effective new trips to Mars and to asteroids across the inner solar system.

Energized by electric power from on-board solar arrays, the xenon gas-propelled system will use 10 times less propellant than a comparable chemical propulsion system.

The new project comes to the TDM family from a maturation period as part of NASA's Game Changing Development Program, where researchers began developing large, radiation-resistant solar arrays capable of more efficiently stowing for launch and then unfurling in flight to capture solar energy. The project also has developed advanced electrostatic Hall thrusters, which accelerate ions by an electric field instead of conventional methods used by chemical-fueled rocket engines. Such a system can accelerate a spacecraft in flight in a microgravity environment to more than 65,000 mph.

...continued on p. 4

2013: The TDM Year in Review

In this first newsletter of 2014, "The Bridge" wanted to take the time to look back at all our TDM successes in 2013, project by project. We asked them to share their own highlights, as follows:

Low-Density Supersonic Decelerator (LDSD)
At the start of 2013, the Low-Density Supersonic Decelerator (LDSD) had just received approval from the Program Management Council to proceed from formulation to implementation. Since then, the project has conducted 12 hardware design reviews; built test beds, ground support equipment and flight development hardware articles; and performed a number of development and qualification/verification tests. The first composite core structure assembly was built and successfully passed static loads testing. The first electronics boxes and wiring harnesses were built, checked out and integrated onto the electronics pallet, which is undergoing final testing at the start of 2014.

The team built and successfully tested two robotic mission Supersonic Inflatable Aerodynamic Decelerator (SIAD-R) flight articles, and the first Exploration mission Supersonic Inflatable Aerodynamic Decelerator (SIAD-E) is in fabrication. They conducted aerodynamic testing of several parachute configurations, resulting in a chosen hybrid ring sail/disk gap band design called a "disk sail." The parachute canopy was fabricated and testing is underway. Design and development of the ballute system which extracts the parachute also has begun.

...continued on p. 2

2013: The TDM Year in Review*...continued from p. 1*

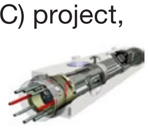
Most of the launch system, including a uniquely designed tower specifically built for LDSD's requirements, has been constructed, delivered and tested. The launch system recently was qualified for flight; its launch date has been tentatively set for June 2014, lifting off from Kauai, Hawaii. The LDSD team presented multiple papers documenting the technology development at an AIAA conference, and developed a middle school experiment for teaching scientific and engineering principles to the students.

Green Propellant Infusion Mission (GPIM)

In 2013, the Green Propellant Infusion Mission (GPIM) project conducted its System Requirements Review and Preliminary Design Review, and is preparing for its Critical Design Review in early 2014. The project completed a significant number of accomplishments in 2013, including identification of a primary and secondary supplier for the catalyst used in the thruster system; successful testing of heavy-weight versions of the 1-Newton and 22-Newton thrusters in pulsed and continuous thrust modes; detailed design of the engineering model designs of the two thrusters; and long-lead procurement for the thruster and spacecraft bus components.

Also in 2013, the 45th Space Wing Range Safety organization at Patrick Air Force Base in Florida approved the GPIM propellant as no greater than a "critical" hazard, whereas hydrazine, the toxic fuel it will replace, is considered a "catastrophic" hazard — a clear indicator of how much safer the new propellant will be to store, transfer and load during ground and flight operations. As 2014 gets underway, the GPIM team is poised to perform testing on the engineering model designs in preparation for the Critical Design Review.

Deep Space Atomic Clock (DSAC)



It's been a busy year for the Deep Space Atomic Clock (DSAC) project, which has developed two experimental models, also called breadboards: the payload breadboard, essential for establishing operational algorithms, and the clock breadboard, used for early interfaces among the electronics. In 2013, the project resolved two issues related to lamp bulb manufacturing and ion tube flight design, and identified the Surrey Orbital Test Bed spacecraft as the host for the flight-demonstration payload. The DSAC payload will be launched as part of the U.S. Air Force Space Test Program's STP-2, on one of its Evolved Expendable Launch Vehicle Secondary Payload Adapter (ESPA) sites.

DSAC has established the Jet Propulsion Lab Type II paradigm, which includes extensive tailoring of business and engineering practices for the project. The project continues to cultivate current infusion customers such the Air Force Research Laboratory and the Jet Propulsion Laboratory's Europa Clipper mission, and new infusion customers including the National Reconnaissance Office and the U.S. Military Satellite Communications Systems Directorate at Los Angeles Air Force Base.

Solar Sail Demonstrator (SSD)

The Solar Sail Demonstrator (SSD) project, dubbed "Sunjammer" by project leads at L'Garde Inc. in Tustin, Calif., has been in the "preliminary to critical design" period in 2013, as the team matured the design of the sail, carrier, avionics and software and conducted numerous development and design confidence tests.

L'Garde conducted extensive subscale and prototype tests on the sail, booms, beam assembly, thermal protection system and vane actuators over the course of the year, culminating in a successful deployment demonstration in ambient conditions of a full-scale beam/sail deployment, using a sail quadrant 89 feet long. The team also conducted a number of informal peer reviews with NASA subject-matter experts on topics such as mission planning; mechanisms; fluids and propulsion; and structures and materials — independent, ongoing review support that also helped L'Garde understand the rigorous expectations of its upcoming Critical Design Review.

Progress will continue in 2014 to finalize not only the detailed design of the Sunjammer hardware and software, but also definition of the final concept of operations and mission planning, as coordination continues to identify a launch provider.

Human Exploration Telerobotics (HET)

In the past year, the Human Exploration Telerobotics project accomplished many firsts for human-controlled telerobotic systems. The International Space Station crew completed the first teleoperation of a humanoid robot aboard the station with Robonaut 2, which also successfully demonstrated manipulation skills during extravehicular activity and intra-vehicular activity, and increased the use of computer vision for robot autonomy.

The first remote operation from Earth of a free-flying telerobotic system also was accomplished on the space station. The Smart SPHERES aboard the station, while under ground control, performed the first robotic survey of the orbiting research facility. These tasks were performed using a commercial smartphone as an embedded space processor.

In summer 2013, crew members on the space station also completed a NASA "first" while supporting HET research on Earth. HET project personnel conducted three Surface Telerobotics sessions at the "Roverscape" at NASA's Ames Research Center in Moffett Field, Calif., during which station crew controlled the K-10 Rover — the first time. They deployed and inspected a simulated film telescope, simulating a human-robot waypoint mission. This was the first real-time, remote operation of a robotic rover from space. Analysis has begun on 25+ gigabytes of engineering data that was collected during the three sessions.

Laser Communications Relay Demonstration (LCRD)

The Laser Communications Relay Demonstration (LCRD) project successfully completed three major design reviews and two key decision points in 2013.

In preparation for the successful Preliminary Design Review in October, the project conducted 22 engineering reviews with each major component and system. The project also began securing contracts for long-lead flight parts for the demonstrator's optical module, control electronics and space switching unit.

Ground engineering unit modems currently are under construction at NASA's Goddard Space Flight Center in Greenbelt, Md., where the project is led for NASA, and flight modem parts also are being ordered. The Lunar Laser Comm Ground Terminal at White Sands, N.M., and the Optical Communications Telescope Laboratory at NASA's Jet Propulsion Laboratory in Pasadena, Calif. — both successfully demonstrated during the Lunar Laser Communications Demonstration (LLCD) mission launched in September 2013 on the Lunar Atmosphere and Dust Environment Explorer (LADEE) vehicle — will be employed for the LCRD demonstration. LCRD builds on the legacy hardware developed for LLCD, including the optical module, control electronics and pulse position modulation technology. Both ground stations have completed robust adaptive optics studies in preparation for ground technology validation testing in 2014.

Cryogenic Propellant Storage & Transfer (CPST)

In 2013, the Cryogenic Propellant Storage and Transfer (CPST) project conducted four industry workshops, sharing the results of technology maturation efforts the project had performed in 2012-13. Documenting and disseminating knowledge gained and lessons learned for the benefit of the aerospace industry in general, the workshops covered topics including composite strut thermal performance; multi-layer insulation penetration heat leak study; analytical tools and performance models; liquid acquisition device outflow and line chill-down, propellant gauging, active cooling and scaling/extensibility from small to large scale. In addition to aerospace industry representatives, the successful workshops drew attendees from the energy and medical industries as well, demonstrating the project's value beyond its primary use in spaceflight.

MSL Entry, Descent and Landing Instrumentation Suite (MEDLI)

Since the Mars Science Laboratory Entry, Descent and Landing Instrumentation Suite (MEDLI) landed successfully on Mars on Aug. 6, 2012, the MEDLI project team has been analyzing and sharing the information gathered by the sophisticated sensors in the vehicle's heat shield. The full set of data was disclosed in 2013, and now is stored in the Entry, Descent & Landing (EDL) Repository at NASA's Langley Research Center in Hampton, Va., which led the project for the agency.

The project was able to make advancements in several areas, including increasing the Technology Readiness Level, or TRL, of off-the-shelf pressure sensors and advanced thermal plugs. This is important because it allows the technology to be available for other uses sooner rather than later. The MEDLI team has published results of the project — and conclusions made about the Mars atmosphere and environment — through multiple conference papers and presentations. An official NASA Technical Memorandum on the MEDLI flight mission is pending. It will document and compile all results of analysis. Additionally, the Journal of Spacecraft & Rockets is preparing a special Mars Science Laboratory edition in 2014; the MEDLI team has submitted two papers for that edition.

Finally, the team received wide recognition for its achievements. NASA Administrator Charles Bolden presented the MEDLI team with a Group Achievement Award in August, and MEDLI was deemed a "2013 Best Practices Honoree" by the industry publication Aviation Week & Space Technology in November.

The Technology Demonstration Missions Program is managed for the agency by NASA's Marshall Space Flight Center in Huntsville, Ala. All TDM projects are sponsored by NASA's Space Technology Mission Directorate. Learn more about the program here.

Supersonic Decelerator Project Achieves Chute Test Success

On Oct. 11, the Low-Density Supersonic Decelerator (LDSD) project achieved another key milestone, successfully demonstrating the ability to deploy and pull a large parachute 110 feet in diameter through the dynamic loads it would experience descending through the Martian atmosphere. The LDSD team used a helicopter to drop the parachute and a rocket sled to pull the chute down via rope and pulley, delivering 90,000 pounds of force as it sped along the desert floor at China Lake, Calif. The project, which is developing a pair of innovative Supersonic Inflatable Aerodynamic Decelerators in addition to the parachute, is led by NASA's Jet Propulsion Laboratory in Pasadena, Calif. (Image: NASA/JPL)

Laser Communication Mission Targets 2017 Launch

By Dewayne Washington

NASA's next laser communication mission recently passed its Preliminary Design Review — a major milestone toward the scheduled 2018 launch of the Laser Communications Relay Demonstration.

The review is a major agency evaluation milestone of the engineering plan to execute the build and launch of the LCRD payload onboard a Space Systems Loral commercial satellite.

"The board concluded that the review was a resounding success," said review chairperson Tupper Hyde. "They met all review success criteria and the LCRD team is ready to proceed with mission plans to conduct this groundbreaking demonstration."

NASA's first long-duration optical communications mission, LCRD involves a two-year demonstration of optical relay services to determine how well the system operates and collect long-term performance data.

The project builds on NASA's highly successful Lunar Laser Communications Demonstration (LLCD) mission. NASA's Goddard Space Flight Center in Greenbelt, Md., leads the project, with significant support from MIT Lincoln Laboratory, NASA's Jet Propulsion Laboratory and Space Systems/Loral (SSL).

As proven during NASA's LLCD mission, space laser communications technology has the potential to provide 10 to 100 times higher data rates than traditional radio frequency systems for the same mass and power. LCRD is a longer-duration mission that will provide the necessary knowledge and experience to operate future mission-critical optical communications systems.

Washington is a public affairs officer at NASA's Goddard Space Flight Center in Greenbelt, Md. Read his complete news story here.

An artist's rendering of the LCRD payload hosted aboard a commercial communications satellite. (NASA/GSFC)

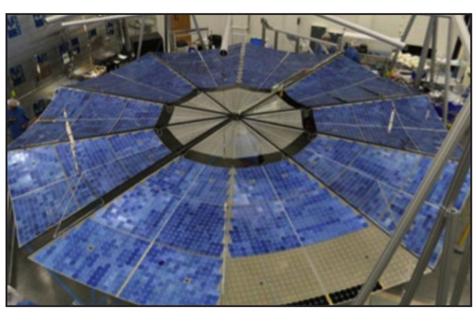
TDM Family Welcomes Solar Electric Propulsion Project *...continued from p. 1*

Numerous critical tests are well underway. Thermal vacuum deployment testing is nearly complete on two types of solar arrays: the ATK MegaFlex from ATK Aerospace, which folds out like a fan, and the DSS Mega-ROSA from Deployable Space Systems, Inc., which rolls out like a carpet. The SEP team also will initiate testing this summer on advanced power processing units, or PPUs, for its Hall thrusters.

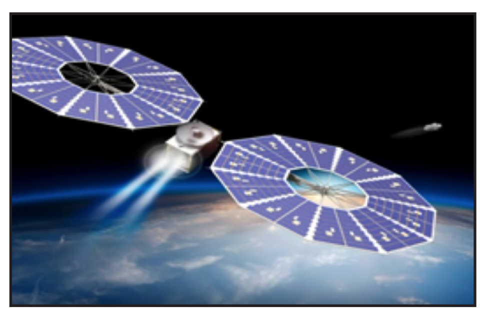
Later this decade, the SEP team will flight-test a Solar Electric Propulsion system in space, seeking to validate its cutting-edge technology and hardware during a high-energy, orbit-transfer mission typically conducted using chemical propulsion.

The Solar Electric Propulsion project is sponsored by NASA's Space Technology Mission Directorate. Learn more about it and other NASA Technology Demonstration Missions here.

Smith, an ASRC Federal/Analytical Services employee, supports the Marshall Center's Office of Strategic Analysis & Communications and edits "The Bridge" for the TDM Program Office.



A deployment test of the MegaFlex solar array, designed by ATK Aerospace Systems to fold out like a fan. (Image: ATK Aerospace)



An artist's rendering of a Solar Electric Propulsion system undergoing flight testing in space. (NASA/GRC)

http://www.nasa.gov/mission_pages/tdm/main

Bridge Builder: Pravin Aggarwal

Pravin Aggarwal—Chief engineer of the TDM Program Office (NASA/MSFC)

Editor's Note: TDM Bridge Builders are team members at NASA centers and partner organizations who are helping bridge the gap, bringing one or more of our cutting-edge TDM technologies to flight readiness. Know a team member worthy of a place in the limelight? Email richard.l.smith@nasa.gov.

The Technology Demonstration Missions Program's chief engineer is Pravin Aggarwal, a 24-year NASA veteran who supports the TDM Program Office at NASA's Marshall Space Flight Center in Huntsville, Ala. He oversees all TDM projects across the agency and executes technical authority for the program office at Marshall and for the Solar Sail Demonstrator (SSD) and Green Propellant Infusion Mission (GPIM) projects. His day-to-day responsibilities include providing consistent, expert engineering support, guidance and oversight in the areas of integration, testing, delivery of flight hardware, launch and ground operations. He also wears a second hat at Marshall, infusing composite materials into design, development and construction projects within the center's Engineering Directorate.

Can you walk us through your typical TDM workday?
A typical day involves working with mission managers to understand their progress, key issues and risk-mitigation strategies. I've tried to establish one-on-one interactions with [the project chief engineers on] our current TDM missions. Two of our missions, however — SSD and GPIM — have no direct chief engineer, because they're managed by the prime contractors working on those projects, so I join mission managers for weekly status meetings to gain additional awareness of those two projects. The work is challenging but very interesting, advancing the TRL levels of key technologies under the Space Technology Mission Directorate umbrella to make future missions feasible and affordable. It's very exciting and fulfilling, and at the end of each day, I look forward to the next.

How do you hope your contributions and your work will impact NASA's TDM goals?
My hope is that I will make a positive contribution by advancing the TRL level through these demonstration missions, making them successful. It is my job to advise the program manager about technical risks, recommending mitigation approaches or risk acceptance. Risks are an inherent part of these demonstrations; that's why they are planned so thoroughly. In the future, when we use these technologies in a flight program, [the work we've done today ensures] that adapting the technology will yield acceptable risk and affordability. In my view, the most important part of my job is to be a problem-solver, a facilitator. I participate in almost all technical, programmatic and risk reviews, and together with the respective project chief engineer, I'm responsible for developing certificates of flight demonstration readiness for each of these missions.

What has been your biggest TDM challenge to date?
I am still fairly new to this job. When I started a few months back, I had [Marshall engineer] Jared Dervan as my assistant chief engineer — and I was spoiled by him! He has since returned to his home office, and in his absence I always seem to be catching up with weekly and monthly notes or just with the acronyms. I hope that I keep meeting expectations, however, and helping to make these missions successful.

What was your first NASA job?
In 1989, I got a phone call asking if I would be interested in a job in the Structures Branch [of Marshall's Engineering Directorate]. I did not know anyone working at NASA then, and I was extremely humbled by the opportunity. I was among the structural engineers responsible for assuring the structural integrity of the awesome space shuttle main engine. I consider that day one of the most important of my life (along with my wedding day, the birthdays of my two beautiful daughters, their weddings and the birth of our grandson)!

What's one thing most people would be surprised to learn about you?
I am from India and came to the United States after finishing my degree in structural engineering. It may surprise people to learn that my mother, who did not have any formal education herself, taught me how to read and write in English. She is a marvelous person.

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